Space Weather Technical Forecast

Issued on Friday, 20 May 2022 at 13:16 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: R1-R2 Radio Blackouts likely. Chance R3 Radio blackouts from AR3014.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate in the last 24 hours with two M-class flares observed, the largest of which was an M3 peaking at 20/0745 UTC from AR3014 Ekc/Beta-Gamma-Delta. This region is the largest and the most complex, with significant delta spot and a large penumbra. Despite its size and magnetic complexity, it is not showing evident signs of growth and appears to be mature and stable.. There are six other sunspot regions on the Earth-facing disc. Nearby region AR3017 acquired some additional spots for a time but these have now started to fade. Region AR3010, in the southwest quadrant, has shown signs of growth in the last few hours, with additional spots in its leading part. All other regions are small and stable, or gradually declining. There were no Earth-directed CMEs observed.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1 remained broadly at elevated levels after a small enhancement was observed at 19/1320 UTC, perhaps associated with the arrival of the fast wind of CH82, but also potentially related to a weak glancing blow from a CME. The solar wind speed increased from 470 to 550 km/s but the rise was slow and came in two waves, perhaps indicating the presence of a weak co-rotating interaction region (CIR) initially. The solar wind density was average but the interplanetary magnetic field (IMF) Bt, exhibited an enhancement from weak values of 5-6nT to 10nT at 19/1320 UTC before slowly coming back down during the rest of the period. The north-south component remained weak, varying erratically between +6 and -6nT with no obvious pattern. The phi angle was mainly positive (away from the Sun). Geomagnetic activity was Quiet to Unsettled.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) has been at Background levels through the last 24 hours. The high energy electron flux (greater than 2 MeV) was at Normal Background levels, with the corresponding electron fluence well below the Active (1e8 integrated pfu). Observed fluence at 20/0000 UTC was 2.84e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Likely to be Moderate, with further M-class flares, and a Chance of an isolated Strong-class flare (R3 Radio Blackout). The main source of the activity is likely to be from AR3014, although some flaring is also possible from AR3017 and AR3010, with a lower chance from the other four regions. A couple of large filaments can also be observed on or approaching the western hemisphere; these will need to be monitored for any potential lift-offs.

Solar Wind / Geomagnetic Activity: A weak CME was observed leaving the sun on the 17/0510 UTC. This has been assessed as most likely passing behind Earth's orbit on day 1 (20th) but it may have already passed (on the 19th). Solar winds are expected to remain elevated on day 1 (20th) otherwise, under the influence of CH82, before slowly easing the

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following days. Geomagnetic activity is forecast to be Quiet with isolated Unsettled spells, but with a chance of an isolated Active period on day 1 (20th).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is expected to be at Background levels during this period, but with a Slight Chance of flux reaching S1, should any notable flares occur. The high energy electron flux (greater than 2 MeV) is forecast to remain at Background levels at first, but may rise over the next few days, with an increased chance of the diurnal peak reaching High levels later in the period. The 24-hour electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold during the forecast period, with perhaps a slight rising trend.

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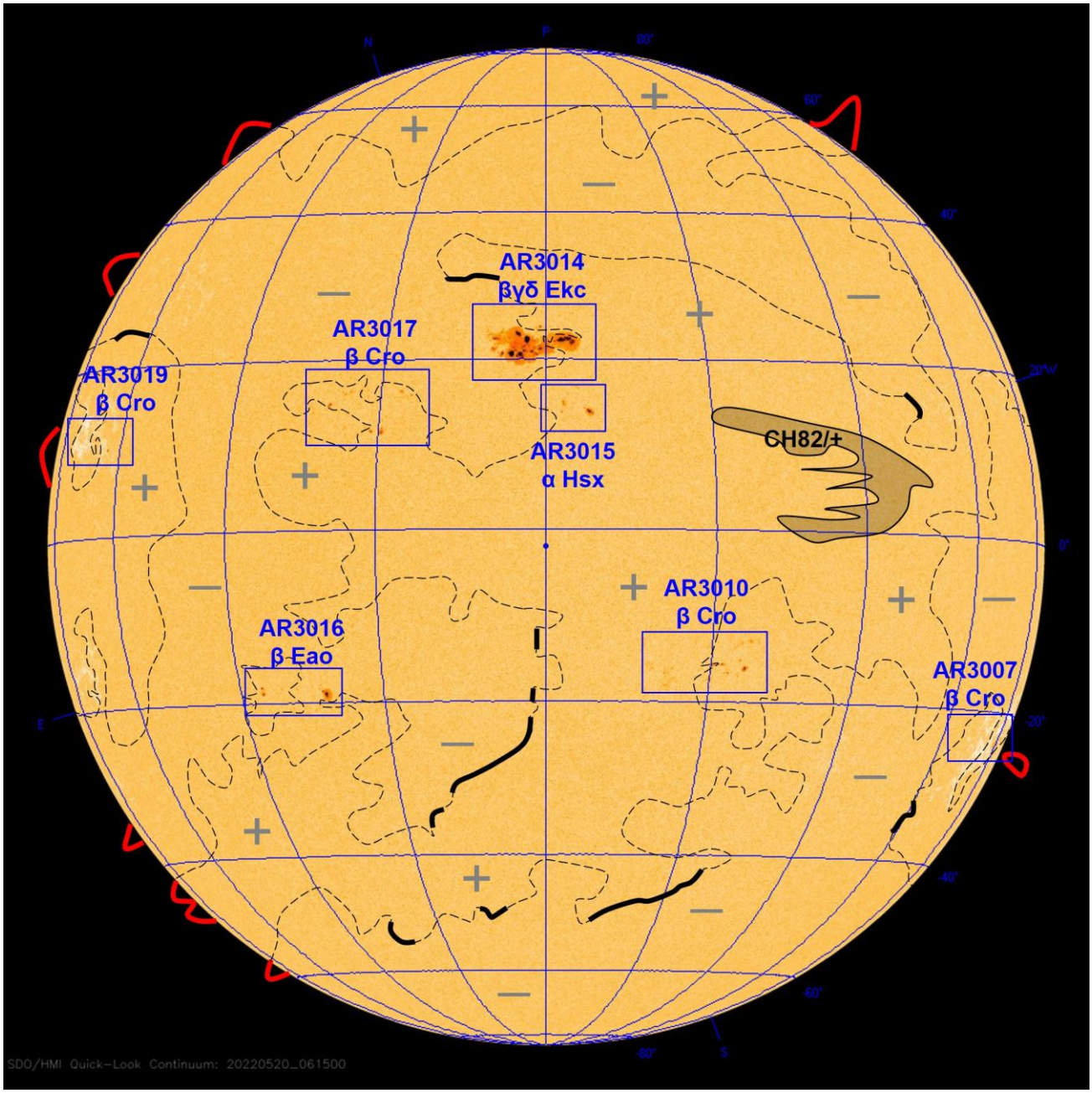
Figure 1. Solar Analysis Valid 20/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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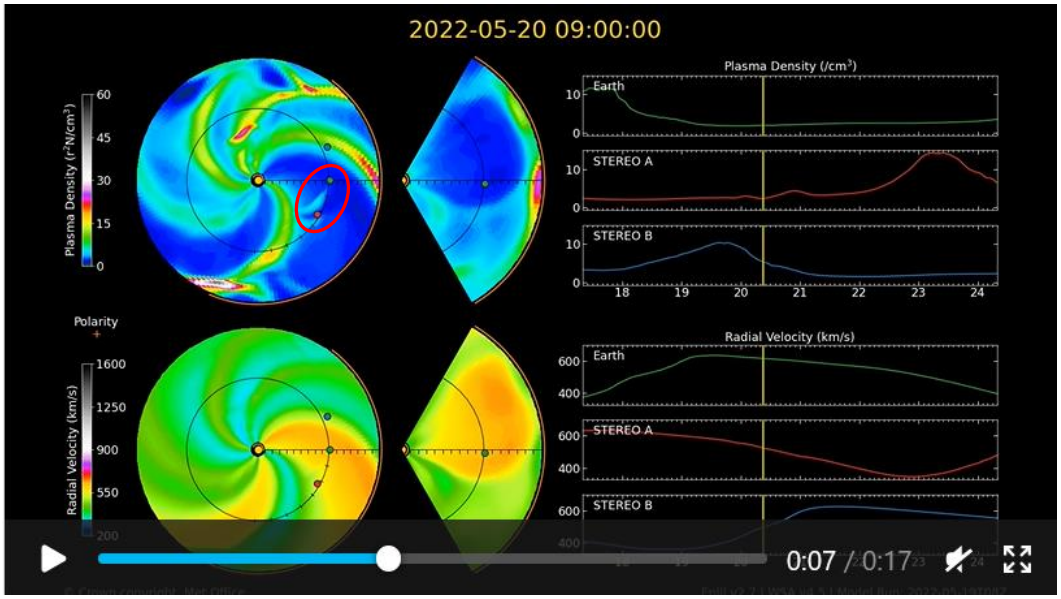
Geomagnetic Storms:
A weak CME was observed leaving the sun in coronagraph imagery during 17 May, likely from AR3015 at 17/0510 UTC. This has been assessed as most likely passing behind Earth's orbit on day 1 (20th), however confidence is very low. As such, there is a very slight chance of a glancing blow, although this is unlikely to have a significant influence on the geomagnetic forecast. There is also a chance that this CME has already passed on the 19th, and was the source of a weak enhancement that has been observed.

Solar winds are currently slightly elevated to elevated, likely due to the fast wind of CH82, however further influence from this feature is possible through day 1 (20th) before easing day 2 (21st) onward. No other significant enhancement to the solar wind or geomagnetic activity is forecast.

Geomagnetic activity is forecast to be Quiet with isolated Unsettled spells, and a chance of becoming Unsettled to Active on day 1 due to any ongoing effects of CH82 and the very slight chance of a glancing CME.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Enlil showing a weak CME missing just behind Earth.



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Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate in the last 24 hours with two M-class flares observed, the largest of which was an M3 peaking at 20/0745 UTC from AR3014 Ekc/Beta-Gamma-Delta.

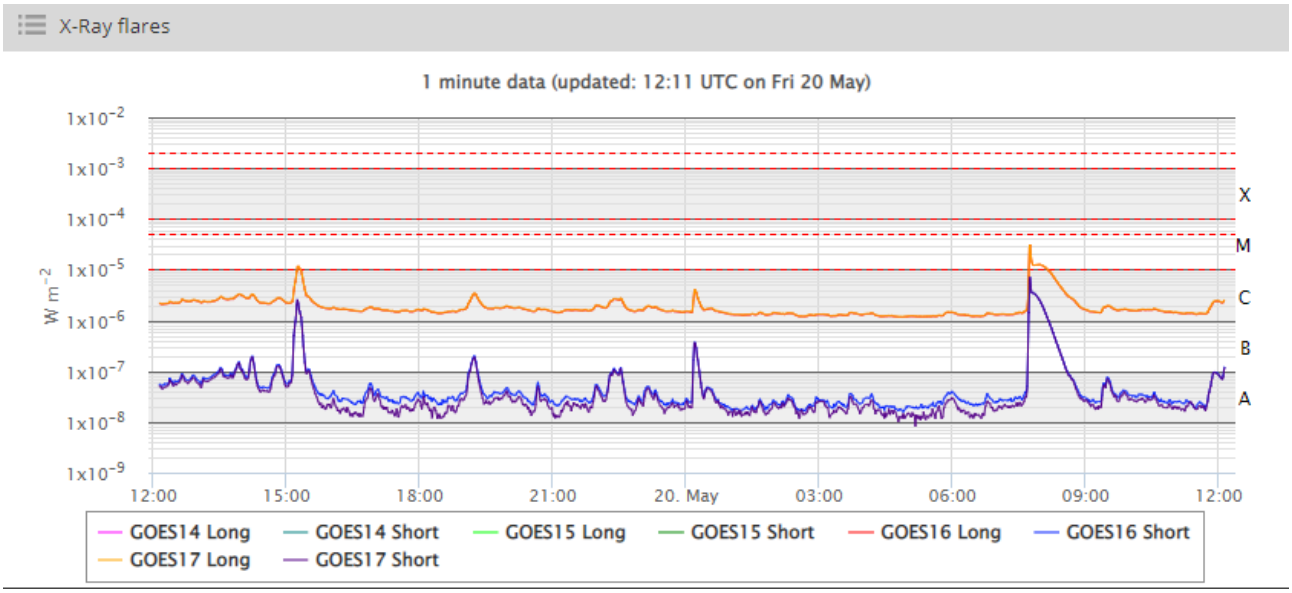
AR3014 remains the most likely source of flaring. This is a large sunspot in the northern central disc, with significant delta spot and a large penumbra. Despite its size and magnetic complexity, it appears to be mature and stable, with no further growth and only small and isolated M-flares so far. However, there remains a chance of isolated X-flaring (R3/Radio Blackout).Otherwise moderate activity is currently likely to continue with further M-flares (R1-R2 Blackout) expected.

There are six other sunspot regions on the Earth-facing disc. Nearby region AR3017 acquired some additional spots for a time but these have now started to fade. Region AR3010, in the southwest quadrant, has shown signs of growth in the last few hours, with additional spots in its leading part. All other regions are small and stable, or gradually declining.

A couple of large filaments can also be observed on or approaching the western hemisphere; these will need to be monitored for any potential lift-offs.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	70
Very Active	R3 to R5 X Class	No	25	20	15	15

Figure 3: GOES-16/17 X-Ray Flux



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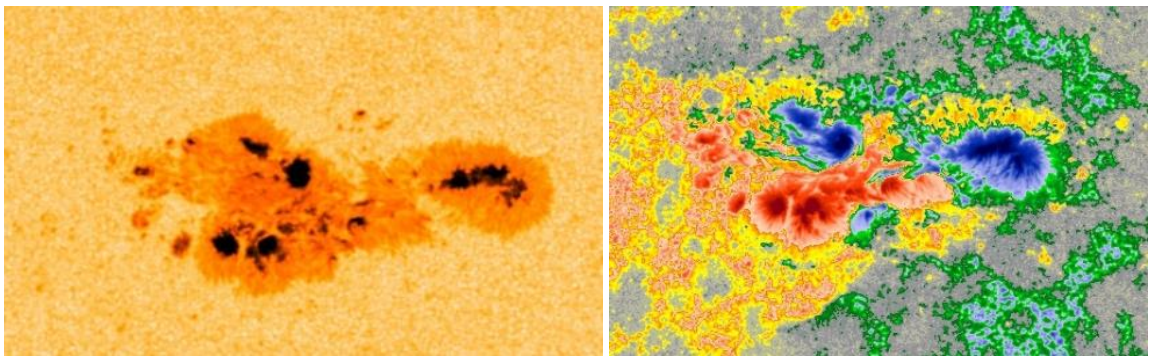
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) is at background levels and is expected to remain at that level through the period. However, there is a slight chance of an S1 or greater event during the forecast period. This is mainly from AR3014, which remains a complex and large sunspot region that will soon move into the western hemisphere. M-class flares are likely from this region, with a chance of X-class flares.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: SDO HMI-Intensitygram and Magnetogram of AR3014



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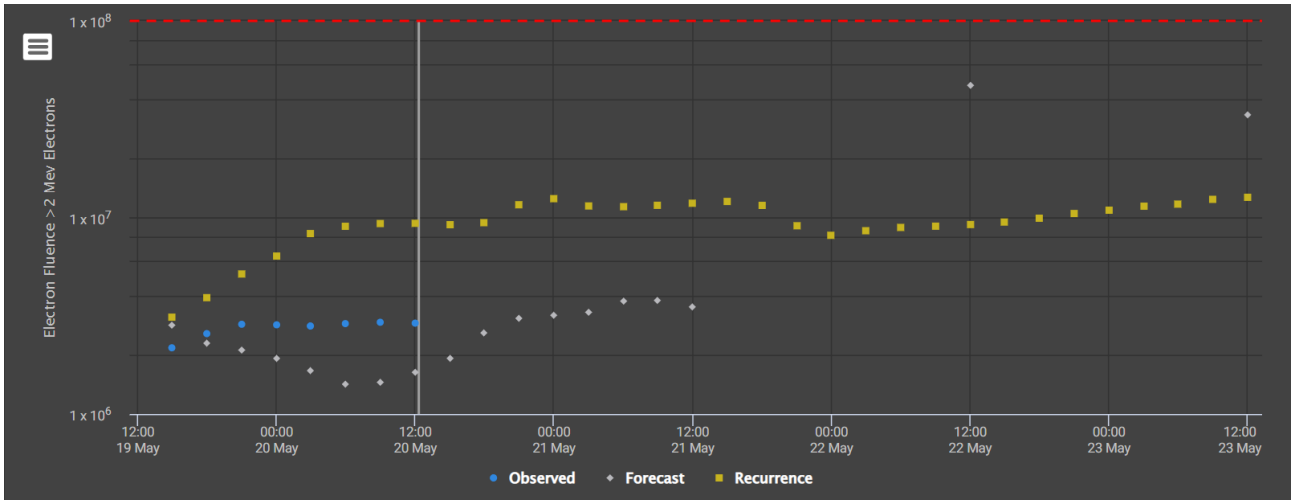
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2 MeV) as measured by GOES-16 at GEO is currently at background to moderate levels. It may rise over the next few days, as fast winds from CH82 ease, but the chances are slim. The increase in speed associated with the arrival of the fast speed stream was gradual and slow, so much so that there was not much compression generated and the co-rotating interaction region (CIR) remained weak. The chance of seeing flux levels reaching High (1000 pfu) levels is therefore possible but only during diurnal peaks.

Corresponding electron fluence is likely to show a slight upward trend through the period, however on balance it is most likely to remain below the Active (1e8 integrated pfu) threshold. This is reflected by current REFM output, although this is currently trending too high on day 2 and 3 (21st and 22nd).

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	5	5
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: Latest REFM output



NOTE: Our REFM model has been upgraded and has changed in appearance. The two main changes are the option to include a recurrence graph, which traces what happened on during last solar rotation for comparison and potential expectation in the coming 3 days (each plot is the observation from T-minus 28 days). Also, the cadence of REFM forecast fluence data is reduced past day 1 to only one value per day. The cadence remains 3-hourly for the first 24 hours.

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